<u>Project Title</u>: Restoring Ecosystem Function through Nitrogen Management

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<u>Introduction to the problem</u>: Throughout the eastern United States, from the Front Range of the Rocky Mountains to the Atlantic Ocean, bioavailable nitrogen has been falling in the rain since the industrial revolution. Bioavailable nitrogen is a limiting nutrient throughout this region. While long-term research conclusively demonstrates that exposure of soil ecosystems to large doses of bioavailable nitrogen leads to deleterious environmental impacts (e.g., eutrophication, toxic algae blooms, hypoxia, toxicity, acid rain, global climate change) that can compromise people's health and the economic vigor of communities, the potential affects of chronic exposure to lower doses of bioavailable nitrogen are relatively unknown.

<u>Background</u>: Symptoms of compromised ecosystem function that may be attributable to chronic exposure to bioavailable nitrogen are widespread; many forests routinely leach nitrogen to surface and groundwater and nitrate concentration in estuaries perturbs aquatic food-webs and affects fisheries. These observations, among others, support the hypothesis that ecosystem function can be (and has been) deleteriously impacted by chronic exposure to low doses of bioavailable nitrogen. To investigate this, in 1998 we initiated an integrated multi-disciplinary study investigating the effects of chronic exposure of ecosystems to low doses of bioavailable nitrogen. We've investigated multiple aspects of biotic and abiotic response to chronic exposure to low doses of bioavailable nitrogen

<u>Objectives</u>: 1) Identify characteristics of ecosystems that make them susceptible to new nitrogen loadings; 2) identify risk management interventions for restore ecosystems deleteriously affected by nitrogen; 3) identify risk management interventions for buffering ecosystems at risk from nitrogen loadings; 4) Identify components of the nitrogen cycle that are susceptible to perturbation by chronic exposure to low levels of nitrogen.

<u>Approach:</u>: Nitrogen loading was manipulated on sixteen 40x40-m study plots in south-central Oklahoma. Plots were manipulated in a factorial arrangement such that 4 plots each received fertilizer only (48 kg/ha/yr), herbivory manipulation only (fence), a combination of fertilizer and herbivory manipulation, or were left as controls. Herbivory was manipulated by a ≐2-m tall chain link fence of 2.5-cm mesh.

<u>Accomplishments</u>: In this nitrogen-limited system, the ability of the soil system to adapt to new nitrogen inputs was compromised after 1 year of exposure when concentrations of nitrate in the soil increased ≐4x. Plant growth was effected by nitrogen application, wherein biomass increased on fertilized plots and diversity was related to distribution of *Festuca arundinacea*. Microbial activity was naturally limited in this system by carbon availability, but this tendency was exacerbated by additional inputs of nitrogen: further, microbial population response was not qualitatively different in soils that received small nitrogen additions vs. soils that received larger nitrogen additions. The presence of large numbers of herbivores coincided with high concentrations of soil nitrate; equivalent to the higher concentrations observed on nitrogen amended plots. We estimate that herbivores may be able to recirculate up to 67% of the bioavailable nitrogen deposited back into the plant and microbial pathways, thereby producing a self reinforcing positive feedback loop leading to ever greater concentrations of soil nitrate and leading eventually to increased nitrate leaching to surface and ground water. The ability of detritus pathways to process nitrogen inputs were compromised after 6 months and this tendency was increased when macroinvertebrate communities were restricted.. These experiments demonstrate that even the relatively small amounts of bioavailable nitrogen that are deposited in precipitation have the capacity to deleteriously effect multiple aspects of ecosystem nitrogen retention, sequestration, and processing.

<u>Near Future Tasks:</u> Continue to monitor changes to plant and soil communities. Identify early indicators of soil ecosystem stress associated with chronic nitrate exposure for use in measuring ecosystem susceptibility and restoration potential.